HHS Public Access
Author manuscript
Occup Med (Lond). Author manuscript; available in PMC 2016 September 01.

Published in final edited form as:
Occup Med (Lond). 2016 June ; 66(4): 292–295. doi:10.1093/occmed/kqw022.

Factors affecting finger and hand pain in workers with HAVS

R. House[1], **K. Krajnak**[2], and **D. Jiang**[3]

[1]Department of Occupational and Environmental Health, St. Michael's Hospital, Toronto, Ontario M5B 1W8, Canada

[2]Engineering and Control Technology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Morgantown, WV 26505, USA

[3]Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba R3E 0W3, Canada

Abstract

Background—Pain and its management are important aspects of hand-arm vibration syndrome (HAVS).

Aims—To determine the factors associated with finger and hand pain in workers with HAVS and, specifically, to assess the impact of several neurological variables as well as the vascular component of HAVS, grip strength and age.

Methods—We assessed men with HAVS at a hospital occupational medicine clinic over 2 years. Subjects scored finger and hand pain separately using the Borg Scale (0–10). The possible predictors we evaluated included the Stockholm Neurological Scale (SNS) and Stockholm Vascular Scale (SVS) stages, current perception threshold (CPT), carpal tunnel syndrome (CTS), ulnar neuropathy, grip strength and age. We carried out nerve conduction testing to confirm the presence of CTS and ulnar neuropathy and measured CPT in the fingers at 2000 Hz, 250 Hz and 5 Hz corresponding to A-beta (large myelinated), A-delta (small myelinated) and C (unmyelinated) fibres, respectively. We calculated Spearman rank correlations to examine the relation between finger and hand pain and possible predictor variables.

Results—Among the 134 subjects, the median (25th–75th percentile) pain scores were 6 (4–8) for the fingers and 5 (1–7) for the hands. We found statistically significant correlations with finger pain for the SVS stage ($r = 0.239$; $P < 0.01$) and CTS ($r = 0.184$; $P < 0.05$). The only statistically significant correlation identified for hand pain was a negative correlation with grip strength ($r = -0.185$; $P < 0.05$).

Conclusions—Management of finger and hand pain in HAVS should focus on the correlates we have identified.

Correspondence to: R. House, Department of Occupational and Environmental Health, St. Michael's Hospital, 30 Bond Street, Toronto, Ontario M5B 1W8, Canada. Tel: + 1 416 864 5074; fax: + 1 416 864 5421; houser@smh.toronto.on.ca.

Conflicts of interest
None declared.

Keywords

Carpal tunnel syndrome; hand-arm vibration syndrome; pain

Introduction

Workers with hand-arm vibration syndrome (HAVS) often experience upper extremity pain [1], which is an important predictor of their upper extremity disability [2], work ability [3] and quality of life [4]. Pain in the upper extremities proximal to the hand in HAVS is thought to be due mainly to musculoskeletal disorders associated with the use of vibratory tools, arising either from the transmitted vibration or ergonomic factors [1]. However, workers with HAVS often report pain in the fingers and hands [5] in addition to more proximal upper extremity pain. Therefore, improved understanding of the cause of finger and hand pain in HAVS would be useful.

We carried out this study to investigate the relation between finger and hand pain and a number of possible predictive factors in HAVS subjects. We were interested principally in assessing the impact of various neurological variables, although we also examined that of the vascular component of HAVS, grip strength and age.

Methods

The study was approved by the Research Ethics Board of St. Michael's Hospital, a teaching hospital affiliated with the University of Toronto.

The subjects were men with HAVS assessed at an occupational medicine clinic over 2 years. Most came from the construction and mining sectors. We asked participants if they frequently experienced any pain in the fingers and hands at any time of year. We did not ask specifically if the pain was cold induced. Finger and hand pain were scored separately on a scale of 0–10 using the Borg Scale. An occupational physician (R.H.) showed all subjects a copy of the Borg Scale during the clinical assessment to standardize the pain rating method.

The clinical assessment also included a history and physical examination to determine the Stockholm Neurological Scale (SNS) and Stockholm Vascular Scale (SVS) stages. We carried out fingertip current perception threshold (CPT) measurements using the NeurometerR CPT/C (Neutron Incorporated), measuring CPT in milliamps at 2000 Hz, 250 Hz and 5 Hz corresponding to A-beta (large myelinated), A-delta (small myelinated) and C (unmyelinated) sensory nerve fibres, respectively. We took CPT measurements on the volar surface of the tips of the index finger (median nerve) and the little finger (ulnar nerve). We also did nerve conduction testing to measure the presence of median neuropathy at the wrist and of ulnar neuropathy. We defined carpal tunnel syndrome (CTS) as the presence of symptoms of CTS with nerve conduction study confirmation of median neuropathy at the wrist. We measured grip strength as the average of three repetitions using a Jamar dynamometer. In all instances, we used the results for the worse side.

We carried out statistical analysis using SAS Version 9.4 and summarized categorical variables as n (%) and continuous variables as mean (SD) if normally distributed or median (25th, 75th percentiles) if not. The Borg pain data were not normally distributed, so we calculated Spearman rank correlations to examine the correlations between finger and hand pain and possible predictor variables including SNS, CPT at various frequencies, CTS, ulnar neuropathy, SVS, grip strength and age.

Results

We recruited 136 consecutive subjects, but two declined participation, so the final sample size was 134. Descriptive statistics are summarized in Table 1. Most subjects (85%) reported finger pain (Borg ≥ 1) and 76% hand pain. Finger and hand pain were significantly correlated ($r = 0.719$; $P < 0.001$). Correlations between pain at each site and the possible predictor variables are summarized in Table 2. The highest correlation with finger pain was obtained for the Stockholm vascular variable ($r = 0.239$; $P < 0.01$). CTS was the only neurological variable with a statistically significant correlation with finger pain ($r = 0.184$; $P < 0.05$). The third highest correlation with finger pain was obtained for the CPT ulnar 2000 Hz variable but this result was not statistically significant and none of the other variables had a statistically significant correlation with finger pain. The SVS stage and CTS were not significantly correlated with each other and therefore their correlations with finger pain were likely to be independent effects, unrelated to confounding. In the hand pain results, grip strength had a statistically significant (negative) correlation ($r = -0.185$; $P < 0.05$). None of the other variables has a statistically significant correlation with hand pain.

Discussion

Finger and hand pain occurred commonly in our HAVS subjects. We identified SVS stage and CTS as statistically significant predictors for finger pain and grip strength for hand pain.

Strengths of the study included a fairly large sample size and careful measurement of clinical data. The main weakness was that this was a cross-sectional study of workers with established HAVS and did not allow evaluation of those with early HAVS. There is evidence from CPT studies in animals that segmental vibration exposure may produce an initial hyperesthesia phase associated with increased sensitivity [6] and possibly pain. Our data did not allow us to assess this issue. Additionally, the direction of causation of some findings such as the negative correlation between grip strength and hand pain is difficult to determine from cross-sectional data.

Our study did not find that the sensorineural component of HAVS (digital sensory neuropathy) was significantly associated with pain. In particular, the SNS stage did not have a statistically significant correlation with finger or hand pain. Previous work has shown that segmental vibration principally affects CPT at 2000 Hz in workers [7, 8] and in animals using the rat tail model [6, 9]. As indicated in Table 2, the correlations of the CPT variables with finger and hand pain were highest at 2000 Hz but none of these correlations was statistically significant.

Author Manuscript

Author Manuscript

Author Manuscript

Ayers and Forshaw, in discussing the need for additional support services identified by HAVS subjects in focus groups and interviews, stated that participants reported a lack of information on alternative pain control methods [10]. This suggests that pain and its management are important aspects of workers' experience of HAVS. Our results identify sources of finger and hand pain for more focused management of pain in workers with HAVS.

Acknowledgments

Funding

Research Advisory Council (grant number 01031), Workplace Safety and Insurance Board, Toronto, Ontario, Canada. The findings and conclusions of this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

References

1. Griffin MJ, Bovenzi M. The diagnosis of disorders caused by hand-transmitted vibration: Southampton Workshop 2000. Int Arch Occup Environ Health. 2002; 75:1–5. [PubMed: 11898868]
2. House R, Wills M, Liss G, Switzer-McIntyre S, Manno M, Lander L. Upper extremity disability in workers with hand-arm vibration syndrome. Occup Med (Lond). 2009; 59:167–173. [PubMed: 19261895]
3. Gerhardsson L, Hagberg M. Work ability in vibration-exposed workers. Occup Med (Lond). 2014; 64:629–634. [PubMed: 25145484]
4. House R, Wills M, Liss G, Switzer-McIntyre S, Lander L, Jiang D. The effect of hand-arm vibration syndrome on quality of life. Occup Med (Lond). 2014; 64:133–135. [PubMed: 24486514]
5. Andréu JL, Otón T, Silva-Fernández L, Sanz J. Hand pain other than carpal tunnel syndrome (CTS): the role of occupational factors. Best Pract Res Clin Rheumatol. 2011; 25:31–42. [PubMed: 21663848]
6. Krajnak K, Waugh S, Johnson C, Miller R, Li S, Kashon ML. Characterization of frequency-dependent responses of sensory nerve function to repetitive vibration. Can Acoust. 2011; 39:92–93.
7. Kurozawa Y, Nasu Y. Current perception thresholds in vibration-induced neuropathy. Arch Environ Health. 2001; 56:254–256. [PubMed: 11480502]
8. House R, Krajnak K, Thompson A, Jiang D. Effect of hand-arm vibration and proximal neuropathy on current perception threshold measurement in the fingers. Can Acoust. 2011; 39:68–69.
9. Krajnak K, Waugh S, Wirth O, Kashon ML. Acute vibration reduces Abeta nerve fiber sensitivity and alters gene expression in the ventral tail nerves of rats. Muscle Nerve. 2007; 36:197–205. [PubMed: 17541999]
10. Ayers B, Forshaw M. An interpretative phenomenological analysis of the psychological ramifications of hand-arm vibration syndrome. J Health Psychol. 2010; 15:533–542. [PubMed: 20460410]

Key points

- In this study, subjects with hand-arm vibration syndrome frequently reported finger and/or hand pain.
- Key predictors identified for finger pain were the Stockholm Vascular Scale stage and carpal tunnel syndrome, and the key predictor for hand pain was grip strength.
- Management of finger and hand pain should focus on these key predictors.

Table 1

Descriptive statistics of study subjects

Variable	Number[a]	Number (%) in specific category	Mean (SD)	Median (25th–75th percentile)
Finger pain	133	113 (85)[b]		6 (4–8)
Hand pain	133	101 (76)[b]		5 (1–7)
CPT median 5 Hz (mAmp)	134			175 (97–250)[c]
CPT median 250 Hz	134			219 (160–290)
CPT median 2000 Hz	134			500 (450–600)
CPT ulnar 5 Hz	134			175 (97–250)
CPT ulnar 250 Hz	134			202 (146–290)
CPT ulnar 2000 Hz	134			450 (370–550)
CTS	132	57 (43)		
Ulnar neuropathy	133	18 (14)		
SNS	134			
0		12 (9)		
1		90 (67)		
≥2		32 (24)		
SVS	134			
0		14 (10)		
1		19 (14)		
2		36 (27)		
≥3		65 (49)		
Grip strength	132		36.8 (12.6)	
Age (years)	134		48.3 (10.7)	

[a]Number of all variables was not 134 due to a small number of missing values.

[b]Number (percent) reporting any pain (Borg Scale score ≥ 1).

[c]The threshold for current perception in healthy individuals varies by current frequency. The upper range of normal by CPT frequency is as follows: 5 Hz: 104 mAmp; 250 Hz: 183 mAmp; 2000 Hz: 401 mAmp.

Table 2

Spearman rank correlations for study variables and finger and hand pain

	Finger pain	Hand pain
CPT median 5 Hz	0.038	0.026
CPT median 250 Hz	0.022	0.024
CPT median 2000 Hz	0.061	0.074
CPT ulnar 5 Hz	0.134	0.064
CPT ulnar 250 Hz	0.099	0.039
CPT ulnar 2000 Hz	0.157	0.118
CTS	0.184*	0.158
Ulnar neuropathy	−0.036	0.009
SNS	−0.011	0.158
SVS	0.239**	0.164
Grip strength	−0.136	−0.185*
Age	−0.036	0.030

*$P < 0.05$,

**$P < 0.01$.